National Certificate of Educational Achievement
TAUMATA MĀTAURANGA Ā-MOTU KUA TAEA

Exemplar for Internal Assessment Resource

Science Level 1

Resource title: Which Fuel?

This exemplar supports assessment against:

Achievement Standard 90945

Investigate the Implications of the Use of Carbon Compounds as Fuels

Enhanced schedule

The moderators have provided supporting information to enhance the assessment schedule so there is clear guidance and more supporting detail for teachers on which to base assessment decisions.

Date version published by Ministry of Education: December 2010
To support internal assessment from 2011

	Grade Boundary: High Not Achieved
1	4 examples of fuels identified, names and structural formulae recorded. Melting and boiling points recorded. Products of complete combustion identified. Implication with respect to greenhouse effect noted but not developed. Word equations are inferred, but not written specifically. In order for an Achieved judgement to be awarded word equations must be written. No implications as per explanatory note 6 of the standard are given that consider the importance and effects of their uses and combustion products on humans or the environment.

1

Which fuel?

Methane, ethanol, hexane and octane are all molecules of hydrocarbons. Methane, hexane and octane are all molecules of the alkane group. Alkanes have no double or triple bonding and have the general formula C_nH_{2n+2}. Ethanol is a primary alcohol. Alcohols have a –OH adding, but form three different alcohols, primary, secondary and tertiary alcohol. It depends on how many carbon atoms are bonded to the carbon atom with the –OH adding. If there is one then it's a primary, if there's two then it's a secondary and with three a tertiary. Alcohols are also very popular as a drug in liquids as beer or wine. But the kind of these molecules is not their only difference. They all also have a different heath enthalpy. Octane has the highest with –5430 kJ/mol at a combustion reaction. Methane has the lowest heath enthalpy of –891 kJ/mol at a combustion reaction.
The structural for

- Methane is : CH_4
- Hexane is : $CH_3CH_2CH_2CH_2CH_2CH_3$
- Octane is : $CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_3$
- Ethanol is : CH_3CH_2OH.

Usually alkanes react with oxygen in a combustion reaction to form carbon dioxide and water. One very important similarity for the task is the fact that all molecules react with oxygen. All these molecules are used as fuels in cars or something else, but it always has something to do with fire and heat. The other side of the coin is that every fuel supports the greenhouse effect, but only in a different grade and in this essay I'm going to find out which one of these four has the best balance between power and the greenhouse effect.
The measurements are for power the heath enthalpy in a combustion reaction for the power per mol and the amount of created carbon dioxide to unleash enough energy. The problem with long carbon chains is the huge amount of energy you need to activate the exothermic reaction. The problem with short carbon chains is that they don't release very much energy, but they don't have high activation energy. But to decrease the activation energy of a long chain alkane you can use a catalyst. A catalyst doesn't only change the activation energy but also the way of the reaction without changing the products.
So I say the best fuel is octane for cars and for longer use even longer chains because you get a high amount of energy and because of this you don't need so much fuel. But for inflaming anything I would use short chain carbons because the released energy is enough in most of cases.

Logbook

Methane:

- Properties:
  - Alkane
  - Molecular formula : CH_4
  - Molar mass : 16.042 g/mol
  - Appearance : colourless gas
  - Destiny (gas, 0°C) : 0.717 kg/m^3
  - Destiny (liquid) : 415 kg/m^3
  - Melting Point : -182.5 °C
  - Boiling Point : -161.6 °C

Reacts with oxygen to form carbon dioxide and water
$CH_4 + 2\ O_2 \rightarrow CO_2 + 2\ H_2O + 891$ kJ/mol.

Ethanol:

- Properties:
  - Primary alcohol
  - Molecular formula : C_2H_5OH
  - Molar mass : 46.08 g/mol
  - Appearance : colourless liquid
  - Destiny : 0.789 g/cm^3
  - Melting Point : -114.3 °C
  - Boiling Point : 78.4 °C

Ethanol can be formed be the ethylene hydration. The equation for this reaction is: $C_2H_4 + H_2O \rightarrow CH_3CH_2OH$.
Another way of forming ethanol is the fermentation:
$C_6H_{12}O_6 \rightarrow 2\ CH_3CH_2OH + CO_2$.

Hexane:

- Properties:
  - Alkane
  - Molecular formula : C_6H_{14}
  - Molar mass : 86.18 g/mol
  - Appearance : colourless liquid
  - Destiny (liquid) : 0.6548 g/cm^3
  - Melting Point : -95 °C
  - Boiling Point : 69 °C

Octane:

- Properties
  - Alkane
  - Molecular formula : C_8H_{18}
  - Molar mass : 114.23 g/mol
  - Appearance : colourless liquid
  - Destiny (liquid) : 0.703 g/cm^3
  - Melting Point : -57 °C
  - Boiling Point : 125.52 °C

Achieve	Merit	Excellence
Moderators would be looking at Explanatory notes 3, 6 and 7 Evidence required from students would be: ○ Name and structural formula given for alkanes and alcohols used. *e.g. Methanol CH_3OH.* ○ Describing selected properties of Carbon Compounds ▪ Melting Point ▪ Boiling Point *e.g.* -183C -164C ○ Two or more Word Equations are included e.g. *Methanol + oxygen → Carbon dioxide and water.* *Methanol + oxygen → Carbon and Water.* ○ Give implications of use as fuels in terms of their importance and effect on humans or environment. *Using Methanol as a fuel could produce soot (solid carbon) which is a health hazard to human lungs.*	Moderators would be looking at Explanatory notes 4, 6 and 7 Evidence required from students would be: ○ Comparison of physical properties (e.g. Melting point/boiling point) and chemical properties (e.g. state) of different carbon compounds. ○ Links made between the properties of different carbon compounds as fuels *Methanol is a gas at room temperature it can be easily compressed into a liquid and is able to be easily transported as a fuel.* ○ Links made between the selected properties of carbon compounds and the implications of their uses as fuels. *Octane burns with a smokier flame compared to Methanol so and so will produce more harmful air pollution.* ○ Two of more correct (not balanced) symbol equations are completed *e.g.* $CH_3OH + O_2 \rightarrow CO_2 + H_2O$	Moderators would be looking at Explanatory notes 5, 6 and 7 Evidence required from students would be: ○ Justifying links between selected properties of different compounds to their uses as fuels *Octane has more energy as a fuel than Ethanol due to the fact it has more chemical bonds to break to release more energy.* ○ Justifying links between selected properties of fuels to their implications of the use of different carbon compounds as fuels. *Ethanol is a renewable fuel source due to the fact that crops can be planted such as corn and soya beans to be used to produce ethanol. These crops can be replanted and so are renewable unlike the crude oil which is used to produce Octane.* ○ Two or more balanced symbol equations are used correctly in addition to explanations consistently using chemistry vocabulary, symbols and conventions. $CH_3OH + 2O_2 \rightarrow CO_2 + 2H_2O$ $CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_3 + 81/2\ O_2 \rightarrow 8CO_2 + 9H_2O$